4.0 POTENTIAL ENVIRONMENTAL IMPACTS

A "graded" approach was used as the basis for analysis of impacts of the proposed action and alternatives. That is, certain aspects of the action have a greater potential for causing adverse environmental impacts; therefore, they are discussed in greater detail in this EA than those aspects with little potential for impact.

4.1 PROPOSED ACTION (4 to 10 mrem/yr Radionuclide Planning Level Increase and WETF Effluent)

4.1.1 Regional Demography/Socioeconomics

The proposed action would not result in a major net change in employment because no additional personnel would be required to operate the existing land application program or be impacted from a reduction in operations associated with EPS at WETF. There would be investment in the construction of a newly fabricated man-hole at the proposed point of discharge from WETF Tank F-8 to the Y-12 Sewer System and the installation of a water meter and properly calibrated pump. These costs are expected to be less than $5,000. This investment would be so small relative to the total level of economic activity in the region of influence that the direct impact would be unimportant and no indirect employment would be generated by the expenditure. The action would result in an operational cost savings of approximately $133,000 due to a reduction in sample monitoring frequency at the WETF NPDES outfall and additional materials (e.g., sulfuric acid, sodium hydroxide, polymers, etc.) required in the operation of EPS. Because operations personnel can be utilized elsewhere within Y-12 Waste Treatment Operations, it would not be expected that not operating EPS would reduce area employment.

The long term implications of this proposed action could result in a positive net change in employment in the City of Oak Ridge commercial sector. Because it is impossible to predict future commercial growth requiring radionuclide discharges to the city sewer system, future financial projections cannot be made. If a commercial discharger does locate in the City of Oak Ridge due in whole or part to the availability of radionuclide discharge capacity to the sewer system, a net positive socioeconomic impact (when compared with other reasonable alternatives) would result from the proposed 10 mrem/yr radionuclide planning levels for the Oak Ridge land application sites.

Environmental Justice

Executive Order 12898 requires federal agencies to achieve environmental justice "to the greatest extent practicable" by identifying and addressing "disproportionately high and adverse human health or environmental effects of its ... activities on minority populations and low-income populations..."

Environmental justice impacts occur if the proposed activities result in disproportionately high and adverse human and environmental effects to minority or low-income populations. Disproportionately high and adverse human health effects are identified by assessing these three factors:

1. Whether the adverse health effects, which may be measured in risks or rates, are significant or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death.

2. Whether health effects occur in a minority population or low-income population affected by cumulative or multiple adverse exposures from environmental hazards.

3. Whether the risk or rate of exposure to a minority population or low-income population to an environmental hazard is significant and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group.

As demonstrated in ***Section 5.1***, ***Cumulative Impacts by Resource Area***, there are no measurable dose or risk impacts to any on or off-site receptors resulting from the proposed actions. All biosolids application sites are on federal land (the ORR), and sites were originally selected, based on physical criteria such as topography, soil type, and surface features (e.g., avoiding wetlands and floodplains) conducive to the land application of biosolids.

4.1.2 Land Use

Implementation of the proposed action would create no major, long-term negative impacts to land uses and would enhance the hardwood forest management use of several of the application sites (DOE 1996). Long-term land use restrictions would be avoided by following lifetime biosolids loading limits, contaminant loading limits, and management controls detailed in the Program Plan (Duratek Federal Services 2000).

4.1.3 Archaeological, Cultural, and Historical Resources

In compliance with Section 106 of the National Historic Preservation Act, DOE consulted with the State Historic Preservation Officer (SHPO) regarding impacts of the original biosolids land application operation in the previous EA (DOE 1996). The response from the SHPO concurred with the DOE determination that the project would have no effect on properties included or eligible for inclusion on the National Register of Historic Places. Because there are no new application sites, only a modification to the radionuclide soil limits in the proposed action and there are no newly identified archaeological areas on the active sites, further consultation is not necessary as no adverse impacts are expected upon ORR archaeological, cultural and historical resources.

4.1.4 Geology and Soils

The land application of city biosolids having increased radionuclide levels will not have any direct impact upon the existing geology of the ORR sites due to the fact that the material is organic by composition and is easily incorporated into the site soils. Adsorption of chemical and radiological contaminants, onto soil particles is the major means for immobilizing these contaminants, generally in the upper 15 cm (6 in.) of the soil surface. Transport of contaminants from the land application of biosolids to groundwater is extremely unlikely unless channels or fissures exist in the soil matrix. For this reason, biosolids application is prohibited in areas with rock outcrops, sinkholes, or other geologic features that could act as channels to groundwater. Buffer zones of 15 m (50 ft) around these features aid in preventing contaminants from entering groundwater sources.

The only measurable impact of the proposed actions would be an incremental increase in the radionuclide loading levels that the application site soils may experience over the life of program operations as described below. Inorganic compounds, heavy metals and other trace parameters in ORR Biosolids Land Application Site soils were evaluated and found to have no significant impact in a previous EA (DOE EA/1042, 1996)

Dose-based radionuclide planning levels for biosolids were developed for use by the city of Oak Ridge for the land application program using the RESRAD computer code (DOE 1996) and very conservative risk assumptions [i.e., residential farmer and pica (soil-eating) child receptors]; this methodology is accepted by TDEC and DOE.

The updated RESRAD modeling (***Appendix D***) for this EA explains how dose-based radionuclide planning levels were calculated to be protective of human health at a maximum dose of 10 mrem/year to the most exposed individual, assuming biosolids application at a rate of 5 tons/acre/year for up to 10 years (equaling 50 tons/acre lifetime loading). The modeling also explains that the assumption of a farm family moving onto the biosolids application site immediately following the final application is overly conservative because of application site restrictions that would prohibit such action.

Raising biosolids radionuclide application site loading planning levels to 10 mrem/yr and discharging treated, WETF effluents into the Y-12 and City of Oak Ridge sewer systems would not result in any impacts to the area's geology because of the program's operating limitations regarding geologic features such as sinkholes (e.g., 50 foot buffer zone). The soils, however, would experience incremental loading of radionuclides as demonstrated in RESRAD modeling (***Appendix D***) associated with the proposed planning level increase to 10 mrem/yr. ***Table 4.1*** lists the risk factors associated with the proposed 10 mrem/yr increase for known radionuclides that are tracked in the current monitoring program.

Table 4.1. Risk Factors Associated with Proposed Increase from 4 to 10 mrem/yr Dose Rate

Radionuclide	4 mrem/yr Risk Factor	10 mrem/yr Risk Factor
Cobalt-60	9×10^{-5}	2×10^{-4}
Cesium-137	7×10^{-6}	2×10^{-5}
Uranium-235	6×10^{-5}	2×10^{-4}
Uranium-238	6×10^{-6}	3×10^{-5}

Source: Appendix D, Stetar, July 2001.

It should be noted that the RESRAD modeling based upon 10 mrem/yr is a worst-case scenario and the resulting risk factors calculated in ***Table 4.1*** are used as boundaries for an on-site resident, which does not currently or is anticipated to exist in the future of the application sites. That said, it is envisioned that the resulting application soil radionuclide concentrations will be substantially lower than the modeled 10 mrem/yr boundary planning levels.

To determine approximate soil radionuclide concentrations at the end of application site life, predictive modeling (***Appendix E***) calculating the average radionuclide levels observed in city biosolids from 1996 to 2000, the remaining land application site life and soil radionuclide concentrations to date, was performed. The results were divided by existing (4 mrem/yr) radionuclide limit, added together with other radionuclide "fractions" and multiplied by 100 to predictive the percentage of the 4 mrem/yr planning level. The percentage loading at the end of each site life was averaged to obtain overall expected radionuclide soil loading percentage. This percentage was then multiplied by the proposed 10 mrem/yr planning level in an effort to demonstrate what dose could be present under normal operating conditions in comparison to the maximum proposed planning level of 10 mrem/yr. A summary of the results is available in ***Table 4.2***. The results demonstrated that the average application site would be loaded to approximately 47.1% of the 4 mrem/yr planning level, resulting in an estimated 1.88 mrem/yr dose at the end of the site life. Using the same 47.1% scaling factor for the proposed 10 mrem/yr planning level would result in a 4.71 mrem/yr dose at the end of the site life if the proposed planning level increase occurred. This would account for the addition of treated WETF effluents and future industrial growth. Therefore, the probability of land application sites attaining the proposed 10 mrem/yr radionuclide soil loading levels are remote, given the existing controls on the ORR Biosolids Land Application Program.

Table 4.2. Predictive Modeling Application Site Lifetime Soil Radionuclide Levels

Land Application Site	Projected % of Soil Radionuclide Planning levels (4 mrem/yr)
Upper Hayfield #1	40.9%
Upper Hayfield #2	39.3%
High Pasture	49.2%
Rogers Site	56.8%
Watson Road	51.3%
Scarboro Road	45.3%
Land Application Site Average	47.1%

The proposed WETF sewer discharge limit of 1,260 grams per month would be included in the limit increase to 10 mrem/yr. Assuming 100% of the uranium discharged to the sewer system would be land applied on the biosolids land application sites, a maximum of 7.56 kg of uranium from WETF would be applied during each year the city operates on the ORR.

On the smallest application site, Upper Hayfield #2, using an average remaining site life of 7 years, this would correspond to a cumulative increase of 0.002 mg/kg of total uranium in the site's soil (***Appendix F***). The resulting calculated radiological risk (Legin 2001) for ORR application site soils is 1 x 10^{-7}. This risk is based upon an actual soil concentration of approximately 2 pCi/g for total uranium. The lifetime soil loading of 0.002 mg/kg converts to 0.7 pCi/g which represents 35% of the calculated risk factor of 10^{-7}, again, well below the DOE and EPA acceptable risk limit of 10^{-4}.

Because of the city's rigorous monitoring and program action levels (City of Oak Ridge 1999) established to prevent the inadvertent land application of biosolids containing elevated levels of radionuclides, biosolids levels would not exceed benchmarks protective of human health and the environment as established by RESRAD modeling. It should also be noted that radionuclide levels for known radionuclides within the city sewer system are well below the proposed level of 10 mrem/yr and the existing 4 mrem/yr dose planning levels for biosolids (***See Appendix B, Table B.4***) and receiving site soils (***See Appendix B, Table B.11***).

The future use of the land for agriculture would not only be allowable but would be enhanced by the biosolids application.

4.1.5 Water Quality

Application Site Surface and Groundwater

A key geological concern associated with land application of biosolids includes the potential impacts to groundwater. Concentration limits established in the 40 CFR 503 regulations were based upon extensive fate, transport and exposure modeling. The Technical Support Document for Land Application of Sewage Sludge (EPA 1992) modeled 14 exposure pathways including migration of metals from the application site to groundwater. The results of this study indicate that metals applied within the regulatory limits have a minimum impact on groundwater due to the strong retention of metals species in the upper few centimeters of a clay rich soil column. Radionuclides of concern in this assessment are metal species as well; consequently, migration of radionuclides through the soil column and the vadose zone will tend to be retarded through sorption in the upper few centimeters of clay rich soil. This retention and retardation of radionuclides will result in minimal impact to the underlying groundwater over time. Because the city produces a Class A sterilized biosolids material, there is no threat of pathogenic contamination for underlying groundwater.

Nitrogen compounds are also not a threat to ORR application site groundwater due to the fact that the application rate is calculated such that it meets the growth requirements for the vegetation on the specific site, resulting in no excess nitrogen available for transport to the groundwater.

Pathogenic, chemical and radiological contaminants in biosolids applied to land may be transported by surface runoff to receiving waters such as streams, ponds, or wetlands. Potential adverse effects from exposure to these contaminants could occur in aquatic organisms in the surface water or in humans or animals drinking the water or consuming food organisms living in the water. Nitrogen or other nutrients in the biosolids could also have potential adverse effects on surface water quality should these nutrients reach excessive levels in the surface water. Most of the application sites on the ORR have a heavy herbaceous cover; reduction of runoff has been related directly to the density of vegetative cover on the site (DOE 1996). In addition, the city will be applying a solid, Class A biosolids material that is free of pathogens or sterilized. The physical state of the biosolids material will be such that when the biosolids material is applied, it will mostly likely remain at the point of application until incorporation into the site soil. The use of buffer zones, heavy vegetative cover and the application of a solid Class A material will substantially reduce any threat to surface waters on or near active land application sites.

Because land application rates are calculated on the nitrogen growth requirements of the vegetation physically located on each individual site, excess nitrogen will not be available for runoff to surface waters or percolation to the groundwater table. Studies (ORNL 1990, 1997) specifically conducted on radiological and heavy metal contaminants land applied on the ORR using city biosolids found that these contaminants remain in the upper 15 centimeters of the receiving site soils and would represent a minimal threat to surface and ground waters. Residual pathogenic organisms contained in the biosolids would be destroyed and will not represent a threat to surface or ground waters. Organic compounds are utilized as a food source by the microbiological organisms in the biological wastewater treatment process and are sometimes found in very low concentrations in biosolids as demonstrated in ***Appendix B, Table B.3***. Organic compounds resulting from the land application of city biosolids (***See Appendix B, Table B.11***) have not been found to accumulate in active land application sites and would not pose a threat to surface and ground waters given the use of existing program management practices.

The ORR Biosolids Land Application Sites have a number of small tributaries and streams that exist in wooded areas and boundaries of the active sites.

These tributaries are protected by a 500 foot buffer zone that prohibits the land application of biosolids material. Surface water monitoring around current biosolids application sites has shown no noticeable degradation of water quality. Surface water sampling from Braden Branch above and below the closed McCoy site showed some nitrate enrichment in the stream from the application site (DOE 1996). Analyses for trace metals showed no important elevations, and the highest concentrations of regulated metals were still an order of magnitude or more below drinking water standards (DOE 1996). This sampling was performed following heavy rain showers in January 1988; the McCoy site was closed in September 1986 (DOE 1996).

Stream sampling of Bear Creek, performed during an intense storm event on May 1, 1990, below an active application site (Chestnut Ridge) showed minimal increases in the concentrations of measured parameters (organics, heavy metals, and fecal coliform bacteria). The data suggested that runoff from the application site had minimal ecological or human health effects. Subsequent sampling indicated that effects to the water quality of Bear Creek from the runoff during the storm event were largely restricted to a short-term increase in nutrient loading, biological oxygen demand, and fecal coliform bacteria (DOE 1996). The active land application sites are mostly open hayfields with dense vegetation that were originally selected because of the absence of streams and large ponds. There are no major streams that are adjacent or run through the existing land application sites.

Although some biosolids land application areas are located near small surface water bodies (***See Table 3.1***), no adverse impacts would be expected if the proposed action is implemented. Prior to TDEC approval, a detailed hydrogeological evaluation of each site was completed. This evaluation established the technical suitability of the sites and any need for surface water and/or groundwater monitoring. In addition, EPA land application requirements state that biosolids shall not be applied to a site that is 10 m (33 ft) or less from surface waters. As a practice, the City of Oak Ridge has maintained a buffer of 150 m (500 ft) around waters of the State on sites where biosolids have been or are currently being applied. It is anticipated that since buffer zones have already been established around designated wetlands, the practice of not applying biosolids within 500 feet continue, regardless of biosolids classification (i.e., Class A or B). Biosolids management practices (*40 CFR 503.14*) also restrict biosolids application during precipitation events or when the ground is frozen or flooded, thereby minimizing the likelihood of runoff. These practices would continue as biosolids are applied on existing ORR sites.

None of the biosolids application sites are located in wetlands. Although some wetlands (old farm ponds) were found at several of the application sites (***Table 3.1***), biosolids application guidelines are sufficiently stringent and clear that biosolids appliers would not unwittingly apply biosolids into one of these wetlands. Boundaries of these wetlands are marked with wetland boundary flagging so that biosolids appliers would recognize wetland boundaries in the field and avoid inadvertent application of liquid or solid biosolids into wetlands.

None of the active land application sites are located within the 100-year flood plain; furthermore, 40 CFR 503 regulations prohibit the land application of biosolids within any area designated as a flood plain. Because 40 CFR 503 standards and Tennessee guidelines for biosolids prohibit application in areas or under conditions that would allow biosolids to enter a wetland or other waters of the United States, no biosolids are or would be applied in 100-year floodplains or wetlands.

City of Oak Ridge POTW Discharge to EFPC

Heavy metal and radionuclides contaminants typically partition (i.e., separate) to the biosolids or solid phase that is land-applied, as opposed to the water phase that exits the City of Oak Ridge NPDES discharge point to lower EFPC (City of Oak Ridge NPDES Permit, 2001). This is based upon historical data collected since the program began in 1984 and the fact that most metals and long-lived radionuclides have a higher density and typically weigh more than water. As a conservative measure to simulate worst case environmental impacts from the proposed action, predictive modeling, RESRAD modeling and risk assessment scenarios assume 100% of the radionuclides and heavy metals would partition to the solids phase and thus, be land applied on the ORR. Therefore, it is anticipated that the NPDES discharge point at the City of Oak Ridge will not be impacted as a result of the increase in the radionuclide levels associated with 10 mrem/yr for the ORR biosolids land application sites. Currently, the City of Oak Ridge only has specific NPDES permit limits for (1) heavy metal (mercury) and (5) toxic organic compounds (carbon tetrachloride, chloroform, tetrachloroethylene, trichloroethylene and methylene chloride). Radionuclide monitoring for treated discharges through the City of Oak Ridge NPDES discharge point is neither required by TDEC or EPA.

West End Treatment Facility Effluents

The human health risk assessment (***Appendix H***) was specifically prepared for WETF contaminants and concluded that the combined chemical and radiological risks of discharging treated wastewaters from WETF into the Y-12 and City of Oak Ridge sewer systems are negligible and are well below the EPA target range for excess lifetime cancer risk. A summary of the assessment results is available in ***Table 4.3***. When compared to risk factors calculated using the existing NPDES discharge limits for WETF, there was no incremental increase in risk. In fact, the risk for discharges to the sewer system substantially drop due to additional treatment provided by the City of Oak Ridge WWTP, the low amount of contaminants for the proposed daily discharge from WETF and the large amount of water that the treated discharges would mix with prior to treatment and discharge through the City of Oak Ridge NPDES discharge point. The risk assessment used extremely conservative assumptions such as 100% of all WETF contaminants were discharged at the proposed maximum levels, traveled through the sewer system and partitioned with the water phase, as opposed to the biosolids phase which is what typically occurs in day to day operations. In addition, the risk assessment simulates a child wading and drinking the treated water as it exits through the respective NPDES discharge points at WETF and the City of Oak Ridge en route to lower EFPC.

Table 4.3. WETF Parameter Concentrations and Associated Risks

Parameter	Monthly WETF Limit (g)	Daily WETF Concentration to Y-12 Sewer System (mg/l)[1]	Daily Oak Ridge NPDES Concentration to EFPC (mg/l)[2]	Associated Risk at City of Oak Ridge Point of Discharge (Including WETF) to EFPC
Arsenic	**8.5**	**0.0111**	**0.00002**	**3.48×10^{-14}**
Benzene	**8.5**	**0.0111**	**0.00002**	**2.91×10^{-10}**
Methylene Chloride	**23**	**0.0301**	**0.00004**	**3.51×10^{-11}**
Uranium-235[3]	**11.3**	**0.0148**	**0.00002**	**4.04×10^{-9}**
Uranium-238	**1248.7**	**1.6364**	**0.00233**	**1.99×10^{-10}**
			Total Chemical and Radiological Risk	**4.59×10^{-9}**

[1]Assumes 28 days per month for discharge at 7,200 gallons per day

[2]Assumes low flow per day in the Y-12 sewer system of 450,000 gallons and 4.6 mgd for City of Oak Ridge Sewer System

[3]Assumes U-235 is at normal enrichment of 0.91%

East Fork Poplar Creek

Both the City of Oak Ridge and WETF NPDES discharge points are physically located on EFPC. The WETF discharge point is located at upper EFPC, whereas the City of Oak Ridge discharge point is located at lower EFPC (***See Figure 1.1***). Discharges from WETF represent a maximum of 1,000,000 gallons, annually. Because discharges from WETF to EFPC represents less than 1% of the total estimated average creek flow of 3.5 mgd, augmenting the discharge route of the WETF wastewater to the sanitary sewer system will not produce a measurable impact upon the flow of EFPC.

Table 4.3 lists projected WETF parameter concentrations at the point of discharge to the Y-12 sewer system, and the resulting concentration of these parameters at the City of Oak Ridge NPDES discharge point. Resulting risk analysis numbers per contaminant at the city point of discharge to lower EFPC were calculated and well within the acceptable EPA and DOE target risk limit of 10^{-4}. Note that not all of the proposed contaminants have risk factors due to the fact that EPA has not developed cancer risk criteria for these parameters.

4.1.6 Floodplains and Wetlands

Biosolids regulations (40 *CFR* 503), Tennessee guidelines, and site selection criteria (DOE 1996) prohibit land application of biosolids in areas designated as wetlands and in areas designated as 100-year floodplains. During the hydrogeologic evaluation of the land application sites (DOE 1996), flood plain areas were identified. Biosolids application in floodplains and wetlands is and would continue to be prohibited so that no impacts would occur.

Thirteen wetlands were identified at seven of the biosolids land application sites (***Table 3.1***). All wetlands are of human origin and are associated with old farm ponds at the sites. Twelve of these wetlands are on active sites and one is on an inactive site (McCoy). None of the biosolids application sites visited were in wetlands. Although some wetlands (old farm ponds) were found at several of the application sites, biosolids application guidelines are sufficiently stringent and clear that biosolids appliers would not unwittingly spray biosolids into one of these wetlands. Boundaries of these wetlands have been marked with wetland boundary flagging so that biosolids appliers would recognize wetland boundaries in the field and avoid inadvertent application of liquid or solid biosolids into wetlands. EPA requires a 10-m (33-ft) distance from surface water for biosolids application to prevent runoff into streams or lakes.

However, in practice, the application of biosolids by the city on the ORR has been restricted from waters of the state by buffer zones (i.e., 500 ft) determined by TDEC.

4.1.7 Climate and Air Quality

No air quality impacts have been identified for the proposed action. Minor odor problems have been reported from a few past biosolids application sites located immediately adjacent to public access highways. Because of the remoteness of most of the ORR biosolids application sites, no odor problems to the public would be expected. The method of biosolids application is via a standard manure spreader for dried Class A biosolids, air quality degradation by pathogens is not a problem. An air dispersion model (***Appendix I***) was performed for to simulate the on-site exposure of a person standing on a biosolids application site inhaling fugitive radioactive particulates downwind during application. Results are listed in ***Table 5.1***.

Table 4.4. Air Dispersion Modeling Results to an On-Site Individual

Radionuclide	Air Activity (pCi/m^3)	Dose (mrem/yr)
Cobalt-60	8.33×10^{-8}	1.12×10^{-8}
Cesium-137	3.23×10^{-8}	7.21×10^{-10}
Uranium-235	6.23×10^{-9}	5.35×10^{-7}
Uranium-238	7.24×10^{-7}	8.33×10^{-5}

Source: Appendix I, Legin, 2001.

The maximum exposure of an individual breathing the biosolids as they are land-applied 260 operational days per year, 8 hours each day is 0.00008 mrem/yr. This level is considered to be negligible. As emissions travel off-site, the concentration of radionuclides drops substantially, resulting in an even lower exposure to an off-site individual.

4.1.8 Ecological Resources

The proposed action would not be expected to result in any adverse impacts to biota. Effects to most wildlife, especially in the short term, would be limited to physical disturbance from the application vehicle. This low ground-pressure vehicle currently follows the same general route within each application site during biosolids application.

This localizes direct physical disturbance to a certain degree, creating wide grassed paths (most application sites are grass fields) as opposed to bare-dirt roads through the application sites. Because of the more open nature of the vehicular paths and the slow speed of the vehicle during application, direct mortality of wildlife during biosolids application is and would continue to be unlikely.

It should be noted that most of these studies involved the use of municipal biosolids application in the reclamation of lands surface-mined for coal, where acidic soil conditions often enhance the mobilization of existing and any added heavy metals. Biosolids applications on mine lands generally have not had an adverse effect on the health of domestic or wild animals (DOE 1996). Although the uptake of radionuclides in plant and animal tissue directly resulting from the land application of biosolids is not know, it is known that the majority of the radionuclides are retained in the upper 15 cm of application site soils (ORNL 1990, 1997). Given the extremely low concentration of radionuclides in application site soils (***See Appendix B, Table B.11***) and the predictive modeling results (***See Table 4.2***), approximately 47.1% of the proposed 10 mrem/yr radionuclide soil planning level would be attained at the end of application site life. Therefore, toxic effects to ecological receptors would not be expected from the proposed action of increasing site radionuclide planning levels to 10 mrem/yr. Because contaminants contained in WETF effluents discharged to the sewer system will ultimately be land applied on the ORR, and are included in the proposed 10 mrem/yr radionuclide and EPA cumulative heavy metal limits for the existing application sites, no additional impacts to ecological receptors is expected. Because the city biosolids material is sterilized (i.e., free of biological pathogens) and land applied in a solid form, the potential for runoff is substantially reduced resulting in a more stable, pathogen free material. In addition, the dried biosolids material does not readily dissolve in water and trace contaminants such as heavy metals, radionuclides and inorganic compounds (e.g., nitrates) are affixed to the biosolids particulates slowly being released over time. This results in trace contaminants that are not readily leachable to surface or ground waters, further reducing any impacts to ecological receptors and waters of the U.S.

4.1.8.1 Threatened and endangered species

Impacts to any state or federally listed species from the proposed modification to the biosolids application program would be avoided or limited by adherence to biosolids application regulations (40 CFR 503). The protected natural areas established by the Oak Ridge National Environmental Research Park exclude the application of biosolids.

No listed plant species were found on any of the biosolids application sites (TN & Associates, 1997). Four of the sites (High Pasture, Upper Hayfield #1 And #2, and Scarboro) are hayfields that are mowed annually. These fields do not provide potential habitat for listed plant species. One site, Rogers, is planted with a diverse array of shrubs, trees, and grasses which provide abundant wildlife and food habitat, but do not contain listed plant habitat. Rocky limestone bluffs encountered adjacent to Rogers application site boundaries was surveyed for listed species, but none were sighted. Approximately half of the Watson Road site is a dead pine plantation undergoing secondary succession or replanting. This site also contains a natural forest and a riparian zone which were surveyed for listed species, but none were identified.

There are two possible explanations as to why no listed plant species were observed in the application areas. First, listed species are more commonly found in undisturbed areas. Most of the application acreage was probably in field or pasture prior to acquisition by the federal government, so the land has been disturbed from its native state for over 50 years (TN & Associates 1997). Second, operation of the biosolids program for the past 17 years has increased soil nutrient concentrations (mostly nitrogen and phosphorus). These nutrients are used more efficiently by fast-growing invasive or weedy species and, over time, the weedy species would out compete native and listed species. Biosolids can eliminate existing, native vegetation (TN & Associates 1997). However, biosolids application also produces desirable effects in agriculture and tree plantations. These sites experience an immediate growth response in both understory and overstory species and a long-term improvement in productivity of the site (TN & Associates 1997).

Biosolids application can have either favorable or detrimental effects on vertebrate habitat, depending on the species. Application requires that vehicular access be maintained. For five of the six study areas this means that the areas are mowed on an annual basis to prevent the development of woody plant species. Mowing maintains the areas in pastureland or hayfield condition, dominated by grassy plant species such as fescue and orchard grass.

Vehicular traffic required to spread biosolids can potentially impact vertebrate habitats. Nests established in the grassy areas where biosolids is applied, would be subject to disturbance by traffic and biosolids application. Application also occurs in the wooded margins around the edges of the grassy areas and also in the abandoned pine plantation areas. Thus, bird nests established in the lower branches of trees and on the ground in these areas could be affected.

Application of biosolids can result in increased heavy metal concentrations in the soils. There is evidence that earthworms can bio-accumulate heavy metals from soils. Thus, animals such as some shrew species and the woodcock (TN & Associates), which consume earthworms as a very high proportion of their diet, are subject to a higher level of exposure. The management program of the ORR application sites, however, strictly adheres to the heavy metal loading limits established by 40 CFR Part 503, thus minimizing the possibility of heavy metal accumulation.

The ORR Biosolids Land Application Sites provide suitable habitat for four species of mammals (Gray bat - *Myotis grisescens*, Indiana bat - *Myotis sodalis*, Eastern wood rat - *Neotoma floridana* and Meadow jumping mouse - *Zapus hudsonius*), one reptile species (Eastern slender glass lizard - *Ophisaurus attenuatus longicaudus*) and six bird species (Northern harrier - *Circus cyaneus*, Vesper sparrow - *Pooecetes gramineus*, Yellow-bellied sapsucker - *Sphyrapicus varius*, Common barn owl - *Tyto alba*, Bachman's sparrow - *Aimophila aestivalis* and Bewick's wren - *Thryomanes bewickii*). These species would use these areas as habitat as a result of the open-field nature of these sites. Therefore, maintaining the sites as hayfields with biosolids application would favor the potential use of these sites by these species.

At the request of the U.S. Fish and Wildlife Service, a Biological Assessment (BA) was performed (***Appendix J***) to evaluate the specific impacts of the proposed actions in this EA upon the federally-endangered Gray and Indiana bats. The results of the BA were that neither of these species would be expected to be impacted, if present, due to restrictions regarding the application of biosolids within 500 feet of a U.S. Waterway, the extremely low levels of radionuclides found in application site soils and plant tissues (***See Appendix J, Tables J.3. and J.4.***) that have been observed through program monitoring and the low occurrence of potential roosting habitat (e.g., caves, exfoliating trees, etc.) on the active application sites. Specifically, the BA found that the proposed action would be unlikely to adversely impact the Gray bat for the following reasons:

- the absence of caves from the ORR application sites, reducing the likelihood of roosting habitat;
- the absence of large water bodies present on the application sites, reducing the likelihood of foraging habitat;
- the established buffer zone of 500 feet around existing bodies of water on the application sites prohibiting the application of biosolids, reducing the likelihood of direct or indirect contact with biosolids being applied if the Gray bat is present; and

- the rigorous radionuclide monitoring program in place and the extremely low to non-detectable levels of radionuclides found in application site soils and vegetation, reducing the likelihood of accumulation of radionuclides within insects that consume vegetation that represent a food source for the Gray bat.

Also, the BA found that the proposed action would be unlikely to adversely impact the Indiana bat for the following reasons:

- the rarity of the Indiana bat species on the ORR;
- the absence of streams present on the application sites, reducing the likelihood of foraging habitat;
- the absence or rarity of exfoliating tree stands that are present or serve as the borders to application sites, reducing the likelihood of roosting habitat;
- the non-disturbance of existing tree stands by the current operations (e.g., lack of tree removal operations), reducing the likelihood of roosting disturbance if the Indiana bat is present;
- the established buffer zone of 500 feet around existing bodies of water on the application sites prohibiting the application of biosolids, reducing the likelihood of direct or indirect contact with biosolids being applied if the Indiana bat is present; and
- the rigorous radionuclide monitoring program in place and the extremely low to non-detectable levels of radionuclides found in application site soils (***Appendix J, Table J.3.***) and vegetation (***Appendix J, Table J.4.***), reducing the likelihood of accumulation of radionuclides within insects that consume vegetation that represent a food source for the Indiana bat.

The state-listed meadow jumping mouse prefers open grassy areas in close proximity to ponds. These ponds are actively avoided in the biosolids application program, and strict adherence to the current guidelines (i.e., 500 foot buffer zones around waters of the state) should be sufficient to protect this species if present.

The state-listed eastern wood rat could occur in the wooded rock outcrop areas that appear at the Rogers, Upper Hayfield #2 and Scarboro Road sites. Self-imposed application program practices prohibit the land application of biosolids within 50 of a rock-outcroppings or sinkholes. It is anticipated that this practice will continue and should provide adequate protection if this species occurs.

Because the state-listed eastern slender glass lizard prefers cutover woodlands and grassy fields, continued mowing as performed in the application program will favor this species. It spends much of its life underground and may not be affected by the vehicular traffic required during application operations.

All six of the state-listed birds that could occur on the ORR Biosolids Land Application Sites prefer either a combination of forest and clearings or open, weedy fields or grasslands. The impact on these species are minimized by avoiding mowing operations in August to allow completion of the second nesting cycle of the breeding season. Mowing of the fields in the current program occurs in later Winter and late Fall. The effect of the actual biosolids application on the nesting success of these species is unknown but would not be expected to be important because of the extremely low levels of contaminants present in the biosolids be applied.

4.1.9 Potential Radiological Impacts

4 to 10 mrem/yr Radionuclide Increase

As described in ***Section 2.1.2***, there are no federal standards for radiological content of biosolids and land application areas. Wastewater discharges from the Y-12 Plant to the city sewer system are conducted in accordance with *DOE Order 5400.5, Radiation Protection of Public and The Environment*. Wastewater discharges from State-licensed facilities are conducted in accordance with NRC, TDEC-Division of Radiological Health and City of Oak Ridge IDP radionuclide concentration release limits.

Under an agreement with DOE, the City of Oak Ridge, and TDEC, the radionuclide levels in the biosolids and land application areas are monitored, and self-imposed, 4 mrem/yr dose-based standards were developed and approved by DOE (DOE 1996) in November 1996. Additionally, workers currently exposed to the biosolids during treatment or application are monitored by the use of Thermoluminescent Dosimeters (TLDs) by an independent party for radiation exposure. To date, no measurable doses have been reported in the history of the program (City of Oak Ridge, 2001).

Workers could be exposed to radionuclides in biosolids by incidental ingestion and inhalation of particulates during handling of biosolids both during treatment and during land application operations.

The human health risk analysis (***Appendix G***) concludes that the combined chemical and radiological risks to employees exposed to biosolids during the land application process are minimal (i.e., 4×10^{-7}) and are within DOE and EPA acceptable risk criteria (10^{-4}) for excess lifetime cancer risk. TLD monitoring of city POTW employees has shown no detectable exposure to radionuclides (DOE 1996).

Transients could be exposed to the biosolids-amended soils. The combined chemical and radiological risks to transients exposed to soil are also minimal (1×10^{-7}) and within the DOE and EPA acceptable risk criteria for excess lifetime cancer risk (10^{-4}). Noncarcinogenic risks were estimated to be <1, for both the worker and the trespasser, indicating that no adverse effects would be expected from exposure to biosolids or biosolids amended soils.

In addition, during the entire operation of the program, no adverse health effects have been noted. The truck/field vehicle driver wears a dosimeter, and no important exposure has been measured. Health physics surveys of former biosolids land application sites found non-detectable levels of radionuclide activity on trees, ground cover, or site soil, nor was there evidence of removable contamination (i.e., no alpha or beta-gamma was detected on personnel or vehicles) (DOE 1996).

Impacts to human health while directly inhabiting the application sites (i.e., resident farmer) from radiological constituents due to the increase from 4 to 10 mrem/yr dose rate show a small incremental increase but remain within acceptable DOE and EPA acceptable risk criteria of 10^{-4}. Moreover, the predictive modeling (***Appendix E***) suggests that application site soils will attain only 47.1% of the proposed 10 mrem/yr planning levels demonstrating that the likelihood of application sites attaining the radionuclide levels in the proposed action are unlikely.

The proposed 10 mrem/yr planning level is extremely conservative considering that established Nuclear Regulatory Commission (NRC) radionuclide clean-up criteria is 25 mrem/yr. When compared to other exposures received by members of the general public on a day to day basis, the proposed planning level is also very conservative. ***Table 4.4*** provides a list of typical exposures to members of the general public in comparison to the proposed application site planning level.

Table 4.5. Typical Exposures Received by Members of The General Public in Comparison with Proposed 10 mrem/yr Dose Rate for ORR Land Application Sites

Activity	Dose (mrem/yr)
Gastrointestinal Series (Upper and Lower)	1,400
CT Scan (Head and Body)	1,100
Radon in Average Household in the U.S.	200
Living in Tennessee	40
Cosmic Radioactivity	31
Natural Radioactivity in the Body	39
Mammogram	30
Smoking Cigarettes (1 pack/day)	15-20
Consumer products (e.g., radon in drinking water)	11
Chest X-Ray	10
Proposed Maximum ORR Land Application Site Soil Planning levels	10
Using natural gas in the home	9
Living near Oak Ridge Reservation	8
Building materials (concrete)	3
Living near a nuclear power station	1
Air Travel (every 2,000 miles)	1

Source: Annual Site Environmental Report 1999

West End Treatment Facility Effluents

A maximum of 7.56 kg of total uranium from WETF operations would be land-applied on the ORR each year, resulting in an increase of 0.04 g/kg in the biosolids and a cumulative level of 0.002 mg/kg for application site soils, respectively. This results in a risk factor of 10^{-7} for the uranium applied on the application sites. As demonstrated in ***Table 4.3***, the cumulative risk of discharging treated effluents from WETF to the Y-12 and City of Oak Ridge sanitary sewer systems is extremely low and well below the DOE and EPA acceptable risk criteria of 10^{-4}. The radionuclide loading levels described above are extremely conservative and truly represent a worst case scenario from a boundary modeling perspective as described in the 10 mrem/yr RESRAD modeling (***Appendix D***).

Appendix K provides a technical memo stating that there is no measurable calculated dose received from a person standing next to the discharge pipe carrying WETF effluent to the Y-12 sewer system. Moreover, incremental exposures to a worker in the sewer system carrying treated WETF effluent would also not be measurable. In the event of a problem, discharges would be immediately halted for emergency repair operations.

4.1.10 Transportation

In a previous EA (DOE 1996) which addressed expansion of the biosolids land application program to include biosolids from ORNL and ETTP, total accidents and casualties (injuries and fatalities) were estimated for transportation of biosolids from ORNL and ETTP to the Oak Ridge POTW and from the Oak Ridge POTW to the application sites. It concluded that total potential accidents or casualties in 10 years of biosolids application would be < 1. The highway accident rates for transportation of biosolids for the City of Oak Ridge solid Class A program would be 2 in 100,000 trips or events. The highway casualty rate for transportation of the City of Oak Ridge Class A Biosolids Program is 1 in 100,000 trips per month. Because the biosolids material is free of pathogens, there is no potential for the spread of contamination during an accident. This is further substantiated by the fact that the total number of trips to and from the application sites has been drastically reduced because of the city's conversion from liquid (~40 trips per month) to solid (~4 trips per month) biosolids application.

It should be noted that since the beginning of the biosolids land application operation in 1983, there has not been a transportation-related spill. In the event of a spill, there is a spill response plan (Duratek Federal Services, 2000) that includes the initiation of proper spill response measures and the notification of essential oversight personnel.

4.1.11 Human Health and Safety

Human health issues of concern are chemical contamination from the biosolids, particularly buildup of heavy metals in the soil, and the survival of residual pathogens (viruses, bacteria, parasites, and some fungi) in the biosolids and soil. These potential health impacts are summarized here.

Heavy metal concentrations in the biosolids are well below the ceiling concentration limits established by EPA (see ***Appendix B, Table B.2***). Because of the historically conservative chemical loading limits of the land application program, chemical contaminants in the receiving soil have remained well below levels of concern for human health effects. As explained in the human health risk assessment for the biosolids land application sites (***Appendix G***), the hazard index (HI) for toxic (i.e., noncarcinogenic) effects from heavy metals is <1, which is within acceptable limits. For cancer effects, risks to the employee applying the biosolids and risks to a transient on the application site are also below the DOE and EPA acceptable value.

Studies indicate that under EPA-approved biosolids application practices, pathogens are not a health risk (DOE 1996). These organisms will not present a problem because they will be destroyed in the city's Class A biosolids treatment process. As a result, City of Oak Ridge biosolids will not contain residual pathogens, reducing any potential pathogenic threat to workers, transients or application operators.

Activities associated with the transportation of the biosolids would comply with DOE notices and regulations on employee health and safety and the spill response plan (Duratek Federal Services 2000), developed specifically for the transport of biosolids from the Oak Ridge POTW to the land application sites.

There are no major occupational health and safety concerns associated with the operations of the truck transporting the biosolids and the field vehicle applying the material. In the event of a spill, the driver is instructed to follow procedures outlined in the spill response plan.

Because there is only one employee operating the truck and the field vehicle, the occupational and health risks (radiological and nonradiological) would be the same as that for the maximally exposed individual (***Appendix G***). The public would not be exposed to the biosolids unless there is an accident involving the transport vehicle in a populated area, which, to date, has never occurred, in the event of which the spill response plan would be implemented. Thus, the radiological and nonradiological impacts to workers and the public would be below limits established by DOE and NRC.

4.1.12 Accidents

Accidents involving the management or transfer of city biosolids at the POTW or on the ORR application sites may occur but are very unlikely. The physical state of the biosolids produced at the city POTW is a dry, pelletized material that is easily managed during transfer from vehicle to vehicle or vehicle to storage areas. The material is Class A and does not pose a pathogenic (i.e., biological) threat. Heavy metal levels must meet EPA land application criteria prior to application and is therefore not a threat to humans or the environment. The trace amounts of radionuclides contained within the biosolids would produce a maximum exposure of 0.14 mrem/yr (***See Table 5.2***) with an associated risk of 4×10^{-7} to a worker, which are below acceptable EPA and DOE limitations. In addition, POTW workers wear dosimeters that are administered by a third party to measure doses received by biosolids at the city POTW. To date, no detectable levels of radiation have been observed for any POTW operations personnel.

Transients (i.e., members of the public) would receive a considerably lower dose of 0.02 mrem/yr with an associated risk of 1×10^{-7}, which is also well below acceptable EPA and DOE limitations.

4.2 ALTERNATIVE 1 (4 to 10 mrem/yr radionuclide planning level increase without WETF Effluent)

This proposed action has essentially the same environmental impacts as assessed in ***Section 4.1*** but would result in the following changes due to the absence of WETF effluents in the Y-12 and City of Oak Ridge sewer systems:

- The estimated annual cost savings of $133,000 associated with minimizing EPS operations and NPDES sampling and analysis would not be realized for WETF operations;

- 7.56 kg of total uranium from WETF operations would not be land applied on the ORR;

- Impacts of any additional pipe installation would not occur and

- Application site soils would not receive an incremental total uranium loading increase of 0.0020 mg/kg for the life of each site from maximum radionuclide discharge levels involving WETF operations. This loading increase corresponds to 0.0014%, or a negligible portion of the proposed 10 mrem/yr planning level.

4.3 ALTERNATIVE 2 (No Action)

This alternative, which is the continuation of the current biosolids application program using 4 mrem/yr radionuclide soil loading planning levels as assessed in a previous EA (DOE 1996) and discharge of wastewaters generated at WETF to upper EFPC, would involve the current costs and environmental impacts of operating the WETF NPDES outfall and treatment costs incurred by using EPS to treat low level contaminant batches of wastewater as described in ***Section 1.2***.

Impacts to water quality would not be important due to the fact that the city would produce a sterilized, solid biosolids material that physically ties up available nutrients and trace contaminants such as heavy metals, radionuclides and inorganic compounds such as nitrates. Because the physical form of the biosolids is in a solid form, the material will remain at the location where it is dispersed after application. The existing program prohibits the application of biosolids material within 500 feet of a wetland or U.S. waterway. Although this practice is not required for Class A biosolids products, it is anticipated that this practice will continue and is protective of established wetlands and other waters of the U.S. or state that are physically located on or near biosolids land application sites.

Impacts to archaeological/cultural/historical resources, climate and air quality or transportation would not be expected for this alternative and are not discussed further in this section.

Impacts to human health and safety would also not be expected for this alternative because of the rigorous EPA 40 CFR 503 Class A biosolids treatment standards that the City of Oak Ridge meets prior to land application. Strict limits on pathogenic organisms, heavy metals and vectors (e.g., flies, etc.) levels in Class A biosolids were established specifically using risk-based criteria to protect human health.

Because the City of Oak Ridge utilizes Class A biosolids standards, adverse impacts to human health would not be expected and are not discussed further in this section.

4.3.1 Socioeconomics

The no-action alternative would not generate employment or population changes that would induce socioeconomic impacts. Current biosolids land application practices would continue and could result in free distribution of the biosolids material to the community which could include home and garden horticultural and agricultural uses.

By not allowing the radionuclide loading limits for ORR biosolids application site soils to be raised from 4 mrem/yr to 10 mrem/yr, City of Oak Ridge industrial growth will be directly impacted. The maximum radionuclide loading planning level would remain at 4 mrem/yr resulting in a reduction in the total amount of radionuclides that would be land applied corresponding to the proposed net 6 mrem/yr dose increase to 10 mrem/yr. This will force the city to severely limit the amount of radionuclides entering the sewer system. Most industrial dischargers presently operate wastewater processes to reduce the total amount of heavy metals and radionuclides entering the sewer system. Additional restrictions on radionuclide discharges above currently authorized limits would require dischargers of radionuclides to install specialized radionuclide contaminant removal processes (e.g., demineralization units, ion exchange resins, etc.) that are very costly and may not entirely remove radionuclides to non-detectable levels.

The other option available to the city would be to directly refuse the radionuclide discharges of contributors altogether. This would be the case in the proposed discharge of treated WETF effluents and the acceptance of the ORNL biosolids in the existing land application program. Treated WETF effluents would not be allowed to enter the sewer system resulting in an unrealized cost savings of $133,000 per year. ORNL biosolids would also most likely be removed from the current beneficial re-use program to enable limited radionuclide capacity within the sewer system. This would result in an additional expenditure of $67,000 per year by DOE and would force ORNL to utilize low level waste disposal as the only other available course of action to dispose of their sanitary biosolids. This could have a direct impact upon the industrial growth and would not provide the City of Oak Ridge with sufficient capacity for future industrial growth that would require radionuclide discharges to the sewer system. In addition, future DOE projects that would require the treatment of sanitary wastewaters containing very low-levels of radionuclides would not be available to DOE-ORO because of the city's limited capacity for growth.

As stated in ***Section 3.1***, it is impossible to forecast the government and industrial need for radionuclide discharges to the City of Oak Ridge sewer system and therefore a projection of lost revenues cannot be accurately determined.

Land application of biosolids on the ORR by the City of Oak Ridge would cease when site loading limits (i.e., 50 tons/acre) are reached. At that time, other options for biosolids management by the city would be required, resulting in non-federal action(s) beyond the scope of this EA.

4.3.2 Geology and Soils

No impacts to the geology of the ORR would result from the no-action alternative; impacts are avoided by program-imposed operating limitations (e.g., no application within 50 feet of rock outcroppings and karst features, such as sinkholes). Until loading limits are reached, soils would continue to receive the monitored application and loading of heavy metals and radionuclides, along with the nutrient-loading and soil improvement benefits. Once loading limits were reached at all approved sites, land application of biosolids would cease on the ORR.

4.3.3 Ecological Resources

Continuation of the biosolids land application program at the current active sites would not be expected to result in adverse impacts to ecological resources of these sites. The application of site evaluation criteria for site approval and the use of sampling and analysis of biosolids, soil, and vegetation during site use limits the potential for adverse impacts to occur. Once the loading limits are reached, land application of biosolids would cease on the current ORR sites. The current biosolids land application program is not considered to impact any listed species. This is because the currently active sites were selected and approved with the avoidance of any impacts to these species in mind. Most of the active sites are grass and hay fields; few listed species prefer this type of habitat. Exceptions to this include the state-listed Vesper and Bachman's sparrow, which nests in large grass fields with infrequent mowing. Infrequent mowing (or burning), while necessary to maintain an area as grass or weedy grass habitat, could result in negative impacts both to nesting attempts by these sparrows. These impacts would occur only if mowing were performed during the reproductive seasons of these species (late April through June).

It should be noted that although these sites could provide suitable habitat, no threatened or endangered species or established habitats were noted during a survey conducted on the ORR biosolids land application sites in 1997 (TN & Associates 1997).

4.3.4 Radiological Impacts

Under the no-action alternative, the handling and application of biosolids using current practices would continue until the loading limits are reached, at which time biosolids application would cease on the ORR. As explained in the human health risk assessment (***Appendix G***), there would be no measurable risks to exposed workers or potential transients. Also, using the predictive modeling for all sites (***Table 4.2***), the most heavily loaded site when the 50 tons/acre nitrogen limit is attained, from a radiological perspective, would be the Rogers Site at 56.8% of the 4 mrem/yr dose planning level. The average lifetime radiological loading result for all sites is approximately 47.1% of the 4 mrem/yr dose planning level for a maximally exposed, resident farmer living on the ORR biosolids land application sites.

4.4 COMPARISON OF ALTERNATIVES

Table 4.5 summarizes and compares the proposed actions, alternatives and their projected impacts.

Table 4.6. Comparison of Alternatives

Action	Summary	Impacts
Proposed Action: Increase ORR biosolids land application site radionuclide loading from 4 to 10 mrem/yr dose-based planning levels and allow the discharge of treated WETF effluents into the Y-12 and City of Oak Ridge sewer systems.	- Minor increase in ORR site soil radionuclide loading levels, - Minor increase in risk factors for application sites; - Projected maximum radionuclide lifetime loading for ORR sites is 47.1% of proposed 10 mrem/yr planning level - Reduction in risk factors from WETF to sewer system (10^{-9}) over WETF to EFPC (10^{-7}) - Reduced operational costs for WETF - Negligible radionuclide increase in city biosolids and ORR site soils directly resulting from WETF discharges - Negligible impact upon EFPC - Allow City of Oak Ridge sufficient radionuclide discharge capacity for future industrial growth	Minimal increase (47.1% of proposed 10 mrem/yr planning level is expected) in health, environmental, and transportation risks over baseline; Worst-case risk factors are below the EPA and DOE accepted value of 10^{-4}
Alternative 1: Increase ORR biosolids land application site radionuclide loading from 4 to 10 mrem/yr dose-based planning levels.	- Minor increase in ORR site soil radionuclide loading levels, - Minor increase in risk factors for application sites; - Projected maximum radionuclide lifetime loading for ORR sites is 47.1% of proposed 10 mrem/yr planning level - Allow City of Oak Ridge sufficient radionuclide discharge capacity for future industrial growth - Negligible impact upon EFPC - Continued additional costs for WETF effluent discharges ($133,000 annually)	Minimal increase (47.1% of proposed 10 mrem/yr planning level is expected) in health, environmental, and transportation risks over baseline; Worst-case risk factors are below the EPA and DOE accepted value of 10^{-4}; 7.56 kg of total uranium will not be land applied from WETF Operations per year
Alternative 2 (No action): Continued biosolids application on the ORR until current loading limits reached; WETF effluents will continue to be treated and discharged to upper EFPC via NPDES discharge outfall #502	- Continued additional costs for WETF effluent discharges ($133,000 annually) - ORNL biosolids treatment at city POTW could be discontinued resulting in an additional operational cost of $67,000 annually - Future industrial growth requiring radionuclide discharges to the sanitary sewer system could be reduced, affecting both government and commercial projects within the City of Oak Ridge	No increase health, environmental and transportation risks; 7.56 kg of total uranium will not be land applied from WETF Operations per year; Impact future City of Oak Ridge industrial growth